(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 250 944 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.10.2002 Bulletin 2002/43

(51) Int Cl.[7]: **A61N 1/39**, A61N 1/37, A61N 1/378, A61B 5/0402

(21) Application number: **02252674.3**

(22) Date of filing: **16.04.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.04.2001 US 835459**

(71) Applicant: **GE Medical Systems Information Technologies, Inc.**
Milwaukee, Wisconsin 53223-3293 (US)

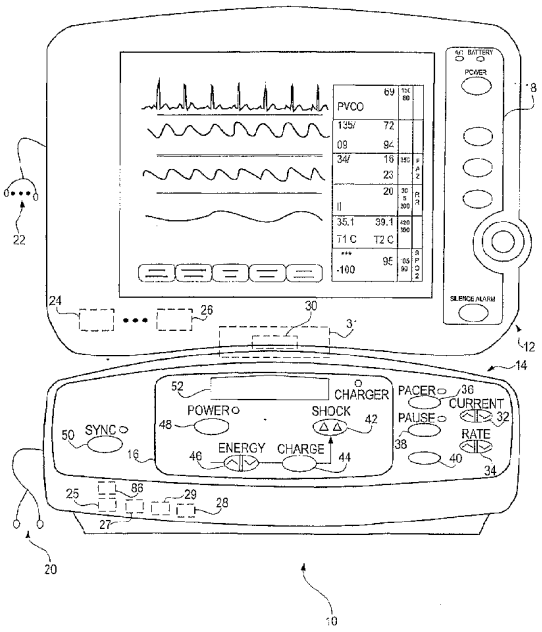
(72) Inventors:
- **Palmer, Michael J.**
  New Berlin, Wisconsin 53151 (US)
- **Gray, James Michael**
  Fox Point, Wisconsin 53217 (US)
- **Schieble, David L.**
  Oconomovoc, Wisconsin 53066 (US)
- **Clapp, Alan Edward**
  Fox Point, Wisconsin 53217 (US)
- **Bayer, Brian Joseph**
  Menomonee Falls, Wisconsin 53051 (US)
- **Loehning, Wilfried**
  79289 Horben (DE)
- **Schulz, Andreas**
  79268 Botzingen (DE)
- **Scholsser Horst**
  79341 Kenzingen (DE)

(74) Representative: **Goode, Ian Roy**
GE LONDON PATENT OPERATION,
Essex House,
12/13 Essex Street
London WC2R 3AA (GB)

(54) Portable patient monitor with defibrillator/pacemaker interface and battery power management

(57) A cardiac treatment and monitoring system is provided. The cardiac treatment and monitoring system includes a patient analyzer unit (12) adapted to detect and analyze processes occurring within a body of a patient, a defibrillator unit (14) releasably coupled to the patient analyzer unit (12) and adapted to receive information about the detected and analyzed processes from the patient analyzer (12) and a power distribution system disposed within the patient analyzer unit and adapted to conditionally share power from a power source (24, 26) of the patient analyzer (12) with the defibrillator (14).

FIG. 1



EP 1 250 944 A2

Description

[0001] The field of the invention relates to cardiac defibrillation and more particularly to portable defibrillators.

[0002] Cardiac arrest can occur in humans for any of a number of reasons. Triggering events may include heart attack, accidental contact with high voltage sources or disease. While the term "cardiac arrest" suggests a total cessation of heart function, a more accurate characterization may be a lack of coordinated contractions among the various segments of the heart. The lack of coordinated contractions may be further characterized by the term "fibrillation". Often cardiac arrest may be reversed through application of an electric shock from a defibrillator.

[0003] Defibrillators have been constructed to operate under a number of different modes. Under a first mode, a defibrillator may deliver a one-time shock (usually in the case of full cardiac arrest) under control of an operator. Under other modes, the defibrillator may receive an R-marker from a heart monitor for other therapeutic processes (e.g., demand pacing, cardioversion, etc.).

[0004] In the case of the sudden onset of cardiac failure, it is often necessary to use defibrillators in a mobile environment (e.g., during ambulance calls). Where used in the mobile environment, a defibrillator must rely upon battery power. However, batteries often deteriorate or become discharged during use. Because of the importance of defibrillators, a need exists for a more reliable method of supplying power to defibrillators in mobile environments.

[0005] According to the invention, a method and apparatus are provided for distributing power within a cardiac treatment and monitoring system which includes a defibrillator releasably coupled to a patient monitoring unit. The method includes the steps of determining a battery reserve capacity within the patient monitoring unit and distributing power from the patient monitoring system to a defibrillator when the determined battery reserve capacity exceeds a threshold value.

[0006] An embodiment of the invention will now be described, by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a front view of a cardiac treatment and monitoring system in accordance with an illustrated embodiment of the invention;

FIG. 2 is a schematic of a connection diagram that may be used to couple a patient monitoring unit of the cardiac treatment and monitoring system to a defibrillator of the cardiac treatment and monitoring system of FIG. 1;

FIG. 3 depicts a power distribution system used by the system of FIG. 1; and

FIG. 4 depicts the cardiac treatment unit and defibrillator of FIG. 1 in connection with a docking station.

[0007] FIG. 1 depicts a cardiac treatment and monitoring system 10, shown generally under an illustrated embodiment of the invention. Included within the system 10 may be a defibrillation unit 14 and patient monitor 12.

[0008] Under illustrated embodiments of the invention, the patient monitor 12 may be releasably attached to the defibrillation unit 14. When detached, each device 12, 14 may be used separately. The defibrillator 14 may be equipped with its own internal power source (e.g., a battery) 28 and internal control system to allow stand-alone use. A control panel 16 may be provided for selection and control of defibrillation processes. A set of leads 20 may be provided to couple an output of the defibrillator to a body of a patient (not shown).

[0009] For example, the operator (also not shown) may activate a power-on button 48. The operator may then activate a power up/down button 46 to select a power level (in Joules) for defibrillating the patient. A selected power level may be shown on a display 52.

[0010] The leads 20 may be applied to the patient. One lead may be applied to the right front chest and the second lead to the left back of the patient.

[0011] Following selection of a power level, the operator may activate a charge button 44. Upon activation of the charge button 44, power from the battery 28 may flow through a voltage to voltage converter 86 and into a shock capacitor 27. By activating the shock button 42, the operator may trigger a switch 25, which applies a defibrillating shock through the leads 20 to the patient.

[0012] The patient monitor 12 may also be provided with its own internal power source (e.g., a battery) 24, 26 and internal control system to allow stand-alone use. A control panel 18 may be provided for selection and control of patient monitoring processes (e.g., electrocardiogram, blood pressure, CO_2, invasive pressure monitoring, blood temperature, cardiac output, blood oxygen saturation, etc.). A set of leads 22 may be provided which may be coupled to the patient for detection of parameters related to a particular patient monitoring process.

[0013] A mechanical interface 31 is provided to secure and mount the patient monitor 12 to the defibrillator 14. An electrical interface (e.g., electrical connector set) 30 may also be provided to couple power and control signals between the monitor 12 and defibrillator 14.

[0014] FIG. 2 depicts a connection diagram showing electrical connections that may be established through the electrical connector set 30. Reference shall be made to FIG. 2 as appropriate to an understanding of the invention.

[0015] Under an illustrated embodiment of the invention, the leads 22 of the patient monitor 12 may be connected to an appropriate set of heart monitoring locations on the body of the patient. Using American Heart

Association (AHA) lead naming convention, the leads may be connected to the left arm, right arm, left leg, right leg and chest.

[0016] A cardiac signal processor 54 may detect a QRS complex of the patient and, in response, generate an R-marker pulse. The R-marker pulse may be transmitted through the connector 30 (e.g., through connector terminal #3) to a defibrillator control CPU 56. Within the defibrillator 14, the R-marker may be used for defibrillator synchronization.

[0017] For example, where a pacer pushbutton 36 is activated, the defibrillator 14 may be used in a pace maker mode. A beat rate and current may be selected through pushbuttons 32, 34 and shown on display 52. A timer 58 within the defibrillator 14 may be used to provide a pacemaker pulse interval. A pulse generator 29 may be used to generate a pacing pulse.

[0018] Alternatively, the operator may activate a demand mode button 40. In the demand mode, the timer 58 is reset each time an R-marker is received from the patient monitor 12. However, if an R-marker is not received within a predetermined time period, the controller 56 triggers the pulse generator 29 thereby pacing the heart in the absence of a detected heartbeat.

[0019] It should be noted, in this regard, that for pacemaking and demand pacing, the pulse generator 29 bypasses the shock capacitor 27. Bypassing the shock capacitor 27 is possible because of the lower energy needs of pacemaking and demand pacing.

[0020] The R-marker may also be used for synchronous cardioversion. As above, an energy level may be selected through the pushbutton 46 and display 52. Upon activation of the shock button 42, the controller 56 may delay application of the cardioversion shock through the leads 20 until detection of the next R-marker from the monitor 12.

[0021] FIG. 3 depicts a power distribution system 70 that may be used by the system 10 of FIG. 1. Under illustrated embodiments of the invention, the monitor 12 conditionally shares power with the defibrillator 14. As is known, defibrillators typically require a battery technology (e.g., NiCd, lead-acid, etc.) which is capable of rapidly charging the shock capacitor 27. However, NiCd or lead-acid batteries have a very poor energy density. Further, in life threatening situations, it is considered better to have a monitor 12 with a dead battery than a defibrillator 14 with a dead battery.

[0022] In general, the defibrillator 14 uses power from the attached monitor 12 in preference to its own power to the greatest extent possible in order to conserve the energy within its own battery 28. Power from the monitor may be used to perform all defibrillator functions other than charging the shock capacitor 27. These functions include (but are not limited to) powering the processor, user interface, pacemaker, and battery charger 82. The pulse generator 29 under control of the CPU 56 functions to raise a voltage of a power supply main 88 to an appropriate level for pacing, cardioversion, etc.

[0023] If the monitor 12 is not present or fails to deliver the necessary power, the defibrillator battery 28 will operate the entire defibrillator 14. In this case, the CPU 56 may activate switch 90 to supply power to the supply bus 88 and to the pulse generator 29. Alternatively, the CPU 56 may activate the voltage-to-voltage converter 86. Activation of the converter 86 charges the shock capacitor 27. Once the shock capacitor 27 is charged, the PCPU 80 may deliver the charge upon activation of the shock button 42 by activation of the switch 25.

[0024] The monitor 12 may have one or more built-in or exchangeable battery packs 24, 26. When the monitor 12 is operating on AC mains power from a plug 60 (FIG. 2), it supplies direct current (dc) power to the defibrillator 14 (FIGs. 2 and 3). When operating in the absence of AC mains power (i.e., on battery power), the monitor 12 makes power available to the attached defibrillator 14 as follows. Under one illustrated embodiment, if the monitor 12 has an equal or greater number of exchangeable battery packs 24, 26 than the defibrillator 14, then the monitor 12 supplies power to the defibrillator 14. Conversely, if the monitor 12 has fewer exchangeable battery packs 28 than the defibrillator 14, then the monitor 12 may not supply power to the defibrillator 14.

[0025] To monitor battery capacity in the monitor 12, a power control processing unit (PCPU) 72 (functioning as a battery reserve capacity analyzer) may monitor battery reserve capacity under any one of a number of formats. For example, battery reserve may be determined by the number of connected batteries or by the charge level of the connected batteries.

[0026] For example, the PCPU 72 may monitor for the presence of battery packs 24, 26 through the use of sensors (e.g., limit switches, proximity detectors, etc.) 74, 76. A charge detector 72 may monitor a charge level of the batteries 24, 26 based upon voltage. Based upon the reserve capacity of the monitor (e.g., greater than 50%) and the number of batteries 24, 26 detected by sensors 74, 76, the PCPU 72 may operate a switch 78 to conditionally supply power to the defibrillator 14.

[0027] Similarly, the defibrillator 14 may consume power under control of a CPU 56. If situations where charging of the shock capacitor 27 is required, the CPU 56, under control of the switch 44, may cause the converter 86 to become active. Activation of the converter 86 causes the battery 28 to charge the shock capacitor 27.

[0028] FIG. 4 depicts a docking station 90 that may be used with the patient monitoring unit 12 or defibrillator 14. The docking station 90 may be used for such things as programming and troubleshooting the patient monitoring unit 12 or the defibrillator 14.

[0029] Included on the docking station 90 may be first and second connectors 30, 92. As shown, the first connector 32 may be used to releasably couple the patient monitoring unit 12 to the defibrillator 14. The second connector 92 may be used to releasably couple the de-

fibrillator 14 to the docking station 90.

[0030] Alternatively, the docking station 90 may be provided with complementary connectors 30, 92. For example, if the patient monitor 12 has a female connector 30 and the defibrillator has a male connector 30, then the docking station may also be provided with a male connector 30. Where provided with complementary connectors 30, 92, the docking station 92 may be coupled to either the patient monitor unit 12 or the defibrillator 14.

[0031] To facilitate use of the docking station 90 with either the patient monitor 12 or defibrillator, connectors 30, 92 may be provided with identification features to identify a connected device. For example, when the patient monitoring unit 12 is coupled to the defibrillator 14, a grounded pin #10 alerts the patient monitoring unit 12 to the presence of a connected device. The patient monitoring unit 12 may then transfer an identity request over a transmit port #12 and monitor a receive port #11 for an identifier. Alternatively, the patient monitoring unit 12 may transmit an identify request over ENET pins #5,7 and monitor ENET pins #6, 8 for a response.

Claims

1. A cardiac treatment and monitoring system comprising:

   a patient analyzer unit [12] adapted to detect and analyze processes occurring within a body of a patient;

   a defibrillator unit [14] releasably coupled to the patient analyzer unit [12] and adapted to receive information about the detected and analyzed processes from the patient analyzer [12]; and

   a power distribution system [70] disposed within the patient analyzer unit [12] and adapted to conditionally share power from a power source of the patient analyzer with the defibrillator [14].

2. The cardiac treatment and monitoring system as in claim 1 wherein the power source comprises a plurality of batteries [24, 26].

3. The cardiac treatment and monitoring system as in claim 2 wherein the power distribution system further comprises a battery capacity analyzer [72] adapted to determine a battery capacity of the patient analyzer unit [12].

4. The cardiac treatment and monitoring system as in claim 2 further comprising a power switch [78] disposed within the patient analyzer unit and adapted to couple power from the plurality of batteries [24, 26] to the defibrillator [14] when the battery capacity analyzer determines that a reserve capacity of the plurality of batteries exceeds a threshold value.

5. A method of distributing power within a cardiac treatment and monitoring system which includes a defibrillator [14] releasably coupled to a patient monitoring unit [12], such method comprising the steps of:

   determining a battery reserve capacity within the patient monitoring unit [12]; and

   distributing power from the patient monitoring system [12] to a defibrillator [14] when the determined battery reserve capacity exceeds a threshold value.

6. An apparatus for distributing power within a cardiac treatment and monitoring system which includes a defibrillator releasably coupled to a patient monitoring unit, such apparatus comprising:

   means for determining a battery reserve capacity within the patient monitoring unit [12]; and

   means for distributing power to a defibrillator [14] when the determined battery reserve capacity exceeds a threshold value.

7. The apparatus for distributing power as in claim 6 wherein the means for determining a battery reserve capacity further comprises means for determining a number of batteries [24, 26] coupled to the patient monitoring system [12].

8. The apparatus for distributing power as in claim 7 wherein the means for determining a battery reserve capacity further comprises means for determining if the number of batteries [24, 26] coupled to the patient monitoring system exceeds a number of batteries coupled to the defibrillator [14].

9. An apparatus for distributing power within a cardiac treatment and monitoring system which includes a defibrillator releasably coupled to a patient monitoring unit, such apparatus comprising:

   a battery reserve capacity analyzer adapted to determine a battery reserve capacity [72] within the patient monitoring unit [12]; and

   a power distribution system [70] adapted to distribute power to a defibrillator [14] when the determined battery reserve capacity exceeds a threshold value.

10. A cardiac treatment and monitoring system comprising:

a cardiac analyzer unit adapted to detect and analyze a QRS complex of a patient;

a defibrillator unit [14] adapted to receive QRS information of the analyzed QRS complex from the cardiac analyzer; and

a power distribution system [70] disposed within the cardiac analyzer unit [12] and adapted to conditionally share power from a power source of the cardiac analyzer with the defibrillator [14].

FIG. 1

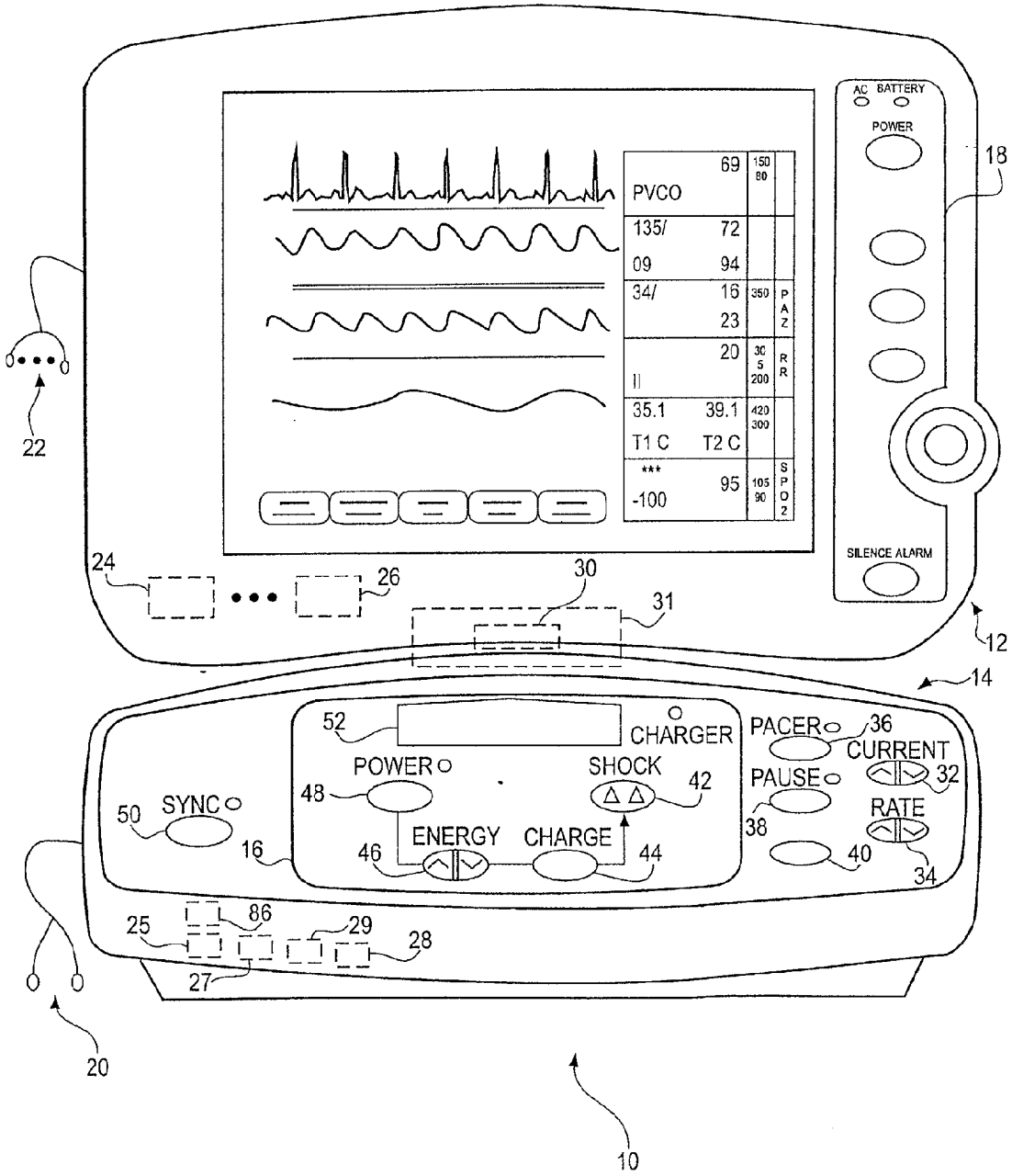

AC BATTERY
POWER
18
SILENCE ALARM
PVCO
69
150
80
135/
09
72
94
34/
16
23
350
PAZ
20
II
30
5
200
RR
35.1
T1 C
39.1
T2 C
420
300
***
-100
95
105
90
SPO2
22
24
26
30
31
12
14
52
CHARGER
PACER
36
CURRENT
32
POWER
48
SHOCK
42
PAUSE
38
RATE
34
50
SYNC
16
ENERGY
CHARGE
46
44
40
25
86
29
28
27
20
10

FIG. 2

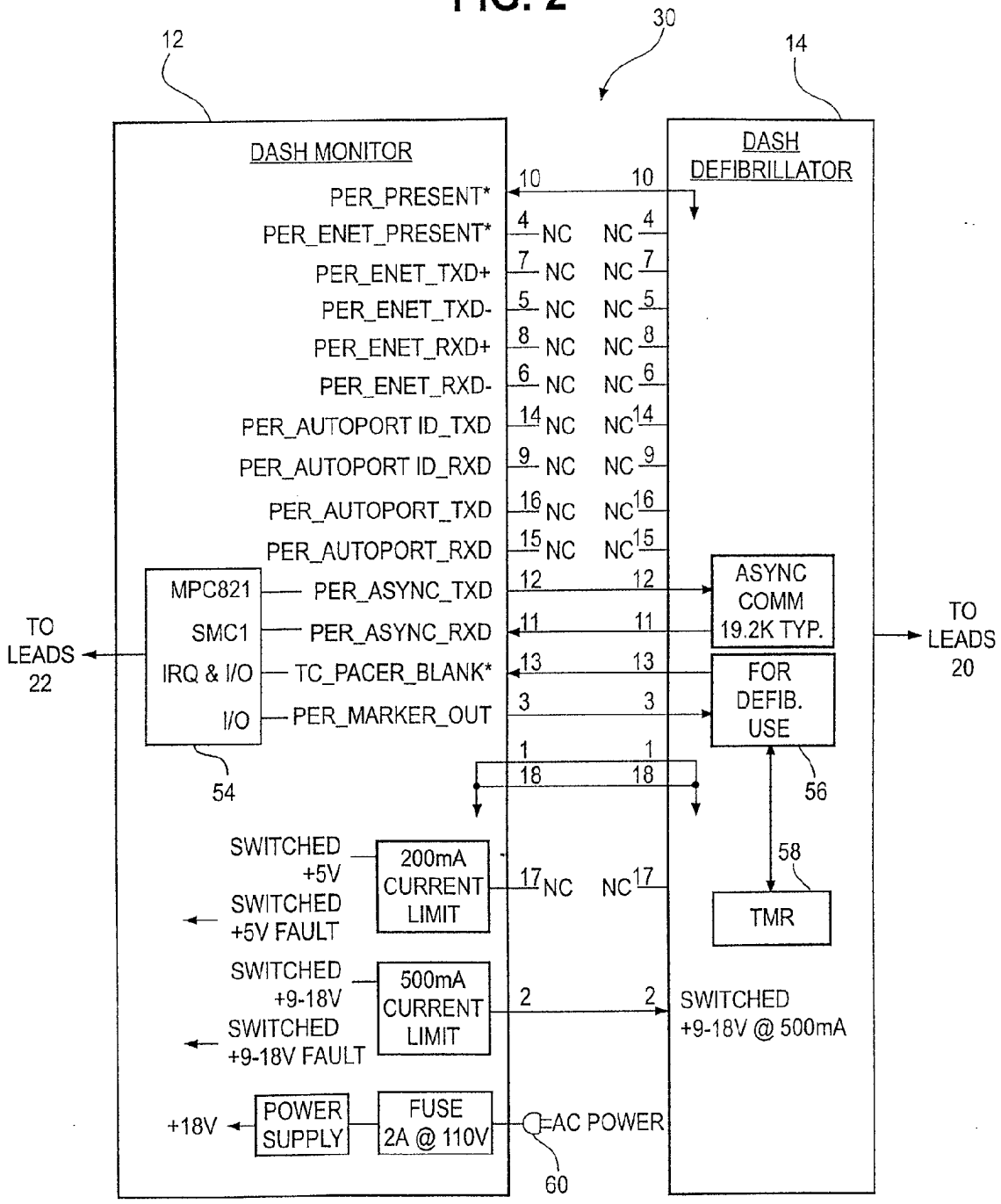

12
30
14
DASH MONITOR
DASH DEFIBRILLATOR
PER_PRESENT*
PER_ENET_PRESENT*
PER_ENET_TXD+
PER_ENET_TXD-
PER_ENET_RXD+
PER_ENET_RXD-
PER_AUTOPORT ID_TXD
PER_AUTOPORT ID_RXD
PER_AUTOPORT_TXD
PER_AUTOPORT_RXD
NC
MPC821
SMC1
IRQ & I/O
I/O
PER_ASYNC_TXD
PER_ASYNC_RXD
TC_PACER_BLANK*
PER_MARKER_OUT
TO LEADS 22
54
ASYNC COMM 19.2K TYP.
FOR DEFIB. USE
TO LEADS 20
56
58
TMR
SWITCHED +5V
SWITCHED +5V FAULT
200mA CURRENT LIMIT
SWITCHED +9-18V
SWITCHED +9-18V FAULT
500mA CURRENT LIMIT
SWITCHED +9-18V @ 500mA
+18V
POWER SUPPLY
FUSE 2A @ 110V
AC POWER
60

FIG. 3

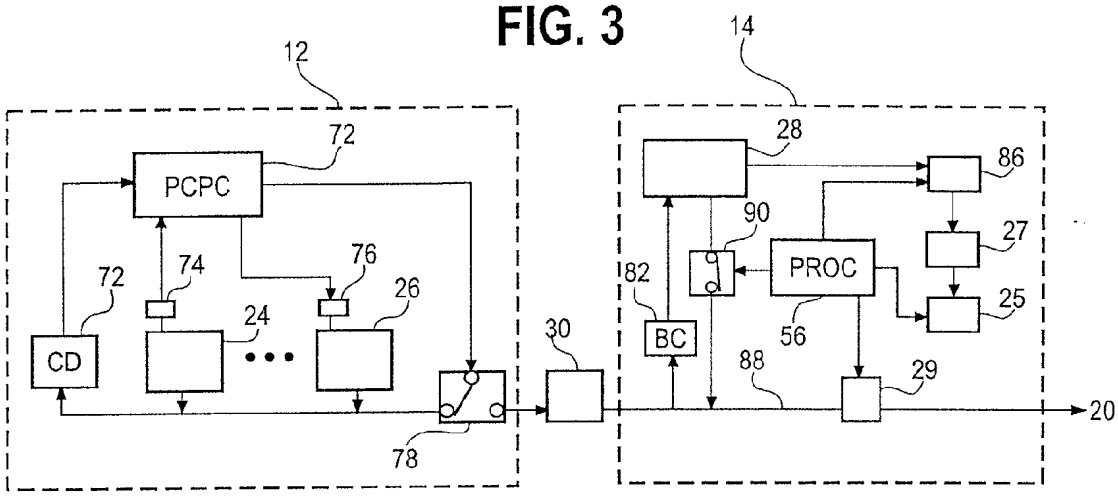
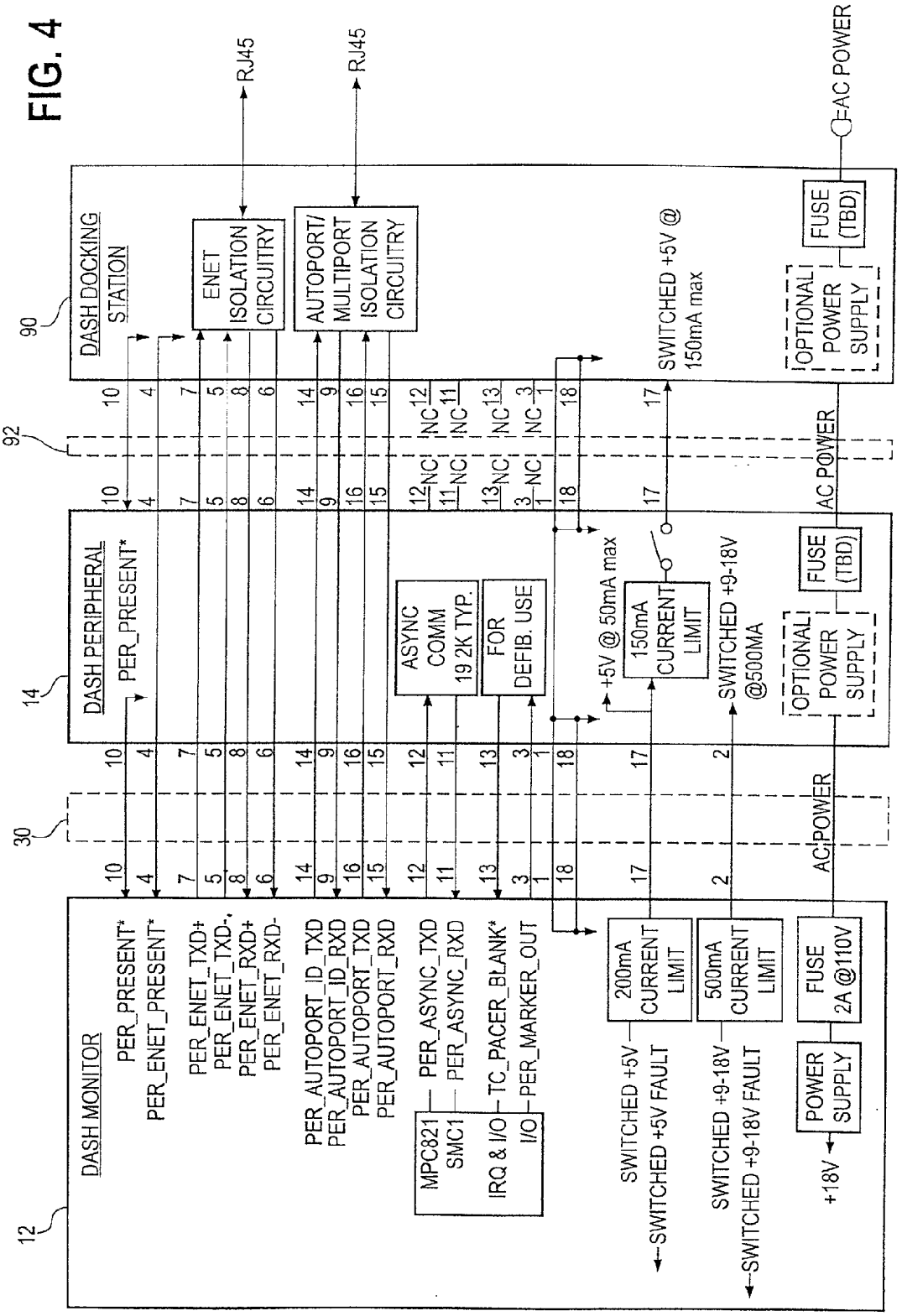

12
14
72
PCPC
28
86
90
27
72
74
76
PROC
82
26
25
24
30
BC
56
CD
88
29
20
78

FIG. 4


12
DASH MONITOR
PER_PRESENT*
PER_ENET_PRESENT*
PER_ENET_TXD+
PER_ENET_TXD-
PER_ENET_RXD+
PER_ENET_RXD-
PER_AUTOPORT_ID_TXD
PER_AUTOPORT_ID_RXD
PER_AUTOPORT_TXD
PER_AUTOPORT_RXD
MPC821 SMC1
PER_ASYNC_TXD
PER_ASYNC_RXD
IRQ & I/O
TC_PACER_BLANK*
I/O
PER_MARKER_OUT
SWITCHED +5V
SWITCHED +5V FAULT
SWITCHED +9-18V
SWITCHED +9-18V FAULT
+18V
POWER SUPPLY
FUSE 2A @110V
200mA CURRENT LIMIT
500mA CURRENT LIMIT
AC POWER
30
14
DASH PERIPHERAL
PER_PRESENT*
ASYNC COMM 19.2K TYP.
FOR DEFIB. USE
+5V @ 50mA max
150mA CURRENT LIMIT
SWITCHED +9-18V @500MA
OPTIONAL POWER SUPPLY
FUSE (TBD)
AC POWER
92
NC
SWITCHED +5V @ 150mA max
90
DASH DOCKING STATION
ENET ISOLATION CIRCUITRY
AUTOPORT/ MULTIPORT ISOLATION CIRCUITRY
RJ45
RJ45
OPTIONAL POWER SUPPLY
FUSE (TBD)
AC POWER